



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/524,227	03/13/2000	Irene T. Spitsberg	13DV13004	6813
30952	7590	10/22/2004	EXAMINER	
HARTMAN AND HARTMAN, P.C. 552 EAST 700 NORTH VAIPARAISO, IN 46383			MARKHAM, WESLEY D	
			ART UNIT	PAPER NUMBER
			1762	

DATE MAILED: 10/22/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/524,227

Applicant(s)SPITSBERG, IRENE T. **Examiner**

Wesley D Markham

Art Unit

1762

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 8/4/2004 (the RCE).
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 13 March 2000 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application on 8/4/2004 after final rejection.

Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office Action (i.e., the Office Action mailed on 4/5/2004) has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 7/5/2004 has been entered. **Claims 1 – 20** remain pending in U.S. Application Serial No. 09/524,227, and an Office Action on the merits follows.

Drawings

2. The formal drawings (4 sheets, 9 total figures) filed on 3/13/2000 are approved by the examiner.

Specification

3. The examiner notes that the word "of" still appears to be misspelled "f" on page 7, line 23 of the specification. However, the applicant states that they were unable to find the aforementioned misspelling and that the error may have occurred during transcription of the application from the applicant to the USPTO. As such, an examiner's amendment can be used to correct the typographical error at an appropriate time, as suggested by the applicant.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 1 and 4 – 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) in view of Nakamura et al. (JP 01-180959 A).
6. Regarding independent **Claim 1**, the AAPA teaches a method of making a thermal barrier coating (TBC) system by depositing a diffusion aluminide bond coat that adheres the thermal barrier coating to a surface of a superalloy component, the method comprising the step of depositing the diffusion aluminide bond coat on the component so as to be characterized by substantially columnar grains that extend substantially through the portion of the bond coat overlying the surface of the component, the grains having grain boundaries exposed at the surface of the aluminide bond coat, and depositing a ceramic layer on the surface of the aluminide bond coat to form a thermal barrier coating (See "PRIOR ART" Figures 2 – 5, page 8, lines 8 – 34, page 9, lines 1 – 35, and page 10, lines 1 – 24, of the applicant's specification, which depict and describe a TBC system of a type known in the art). The AAPA does not explicitly teach improving the thermal fatigue life of the TBC by

modifying the grain structure of the aluminide bond coat by recrystallizing at least a surface region of the aluminide bond coat during or prior to depositing the TBC on the surface of the bond coat, wherein new grains form at the surface of the bond coat. Nakamura et al. teaches that, after depositing a diffusion coating layer of Al (i.e., an aluminide bond coat) on the surface of a gas turbine component such as a blade (i.e., a process analogous to that taught by the AAPA), the diffusion coating layer is shot-peened and then heated to a temperature at or above the recrystallization temperature of the coating layer, thereby causing recrystallized grains (i.e., "new grains") to form on the surface of the diffusion coating layer (Abstract). This recrystallization process advantageously allows the component / coating (1) to have an improved thermal fatigue resistance without deteriorating the corrosion resistance, (2) to have a low crack propagation speed due to the small grain size of the recrystallized grains, and (3) to have an increased resistance to the coating layer peeling-off (Abstract). Therefore, it would have been obvious to one of ordinary skill in the art to improve the thermal fatigue life of the TBC system of the AAPA by modifying the grain structure of the aluminide bond coat by recrystallizing at least a surface region of the aluminide bond coat during or prior to depositing the TBC on the surface of the bond coat, wherein new grains form at the surface of the bond coat, as taught by Nakamura et al., with the reasonable expectation of successfully and advantageously providing the coated superalloy component / blade of the AAPA with the following benefits: (1) an improved thermal fatigue resistance,

(2) a lower crack propagation speed, and (3) an increased resistance to the peeling-off of the coating layer (i.e., the TBC system).

7. The combination of the AAPA and Nakamura et al. also teaches all the limitations of **Claims 4 – 10** as set forth above in paragraph 6 and below, including a method wherein / further comprising:

- Claim 4: The new grains have a grain size of not smaller than 5 micrometers after recrystallization. Specifically, although Nakamura et al. teaches that the new grains are “small” and “fine” (Abstract), Nakamura et al. is silent as to the specific size of the recrystallized grains. However, the combination of the AAPA and Nakamura et al. teaches each and every process step and limitation of the applicant’s claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the grain size obtained by the applicant’s claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA and Nakamura et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA and Nakamura et al. would have inherently produced new grains having a grain size of not smaller than 5 micrometers unless essential process steps and/or limitations are missing from the applicant’s claims.

- Claim 5: The new grains are substantially equiaxed. Specifically, Nakamura et al. is silent regarding the orientation of the recrystallized grains. However, the combination of the AAPA and Nakamura et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the grain orientation obtained by the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA and Nakamura et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA and Nakamura et al. would have inherently produced substantially equiaxed grains unless essential process steps and/or limitations are missing from the applicant's claims.
- Claim 6: The aluminide bond coat is a single-phase or two-phase aluminide prior to recrystallization (page 9, lines 17 – 22, of the applicant's specification).
- Claim 7: Precipitates are present in the grain boundaries of the grains after the depositing step and before recrystallization (see, for example, page 9, lines 29 – 35 of the specification), and the precipitates are substantially absent from the grain boundaries of the new grains after recrystallization. Specifically, the combination of the AAPA and Nakamura et al. is silent

regarding precipitates at the grain boundaries after recrystallization. However, the combination of the AAPA and Nakamura et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature.

Since the lack of grain boundary precipitates obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA and Nakamura et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA and Nakamura et al. would have inherently produced a bond coat having substantially no precipitates at the grain boundaries after recrystallization unless essential process steps and/or limitations are missing from the applicant's claims.

- Claim 8: The aluminide bond coat is single-phase aluminide after recrystallization. Specifically, the AAPA teaches that the bond coat, as deposited, is a single-phase or two-phase diffusion aluminide (page 9, lines 17 – 19, of the applicant's specification). Additionally, the combination of the AAPA and Nakamura et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat deposited, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at

a temperature at or above the recrystallization temperature. Since the single phase aluminide obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant (for support, see, for example, page 14, lines 18 – 20 of the applicant's specification, which indicates that a bond coat recrystallization process yields a single-phase), and the combination of the AAPA and Nakamura et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA and Nakamura et al. would have inherently produced a bond coat having a single-phase aluminide structure unless essential process steps and/or limitations are missing from the applicant's claims.

- Claim 9: Following the depositing step, the surface of the aluminide bond coat has surface irregularities as a result of grain boundary ridges defined by the grain boundaries at the surface of the aluminide bond coat (AAPA at Figure 2, page 9, lines 1 – 35, and page 10, lines 1 – 7), and following the recrystallizing step, the new grains cause the surface of the bond coat to be smoother and flatter as a result of eliminating at least some of the grain boundary ridges, whereby the ceramic layer is deposited on the smoother and flatter surface of the aluminide bond coat. Specifically, the combination of the AAPA and Nakamura et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat deposited, the step of peening the bond coat prior to heat-treating the bond

coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the flattened grain boundary ridges and smoother bond coat surface obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA and Nakamura et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA and Nakamura et al. would have inherently produced a bond coat having flattened grain boundary ridges and a smoother bond coat surface on which the ceramic layer is deposited, as required by Claim 9.

- Claim 10: The aluminide bond coat is a platinum aluminide bond coat (page 9, lines 11 – 19 of the applicant's specification).

8. Claims 2, 11, and 13 – 18, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) in view of Nakamura et al. (JP 01-180959 A), and in further view of Loersch et al. (USPN 4,514,469).
9. The combination of the AAPA and Nakamura et al. teaches all the limitations of **Claim 2** as set forth above in paragraph 6, except for a method wherein the recrystallization is induced by peening the bond coat at an intensity of at least 6A prior to heating the bond coat. Specifically, Nakamura et al. teaches inducing the recrystallization by peening the bond coat prior to heating the bond coat (Abstract) but does not explicitly teach the claimed peening intensity. As verified by an oral

translation from a USPTO translator, Nakamura et al. is silent regarding the specific peening intensity. However, it is clear that the peening intensity of Nakamura et al. must be high enough to induce plastic deformation to the diffusion coating layer (Abstract). Loersch et al. teaches that, in the art of peening bond coatings on metal workpieces such as turbine airfoils, the peening intensity must be high enough to achieve a good surface finish (e.g., closure of surface defects) in an economical period of time, but not so high as to chip or physically degrade the coating (Col.6, lines 54 – 68, and Col.7, lines 1 – 21). In other words, Loersch et al. teaches that the peening intensity is a result / effective variable that must be chosen / optimized to be high (i.e., to achieve a good surface finish in a short amount of time) but not too high (i.e., so that the coating or workpiece is not damaged). Therefore, it would have been obvious to one of ordinary skill in the art to optimize the peening intensity of the process of the combination of the AAPA and Nakamura et al. as a result / effective variable through routine experimentation in order to obtain a peening intensity that is high enough to achieve a good surface finish (i.e., high enough to provide the plastic deformation desired by Nakamura et al.) but not so high as to damage the aluminide bond coating or the workpiece itself.

10. Regarding independent **Claims 11 and 20**, the AAPA teaches a method of making a thermal barrier coating (TBC) system by depositing an aluminide bond coat, specifically a diffusion aluminide bond coat, that adheres the thermal barrier coating to a surface of a superalloy component, the method comprising the steps of depositing the diffusion aluminide bond coat on the component by VPA or CVD; the

bond coat comprising an additive layer on the surface of the component and a diffusion zone in a surface region of the component, the additive layer being characterized by substantially columnar grains that extend from the diffusion zone to the surface of the bond coat, the grains having grain boundaries exposed at the surface of the aluminide bond coat, and then depositing a ceramic layer to form the TBC on the bond coat (See "PRIOR ART" Figures 2 – 5, page 8, lines 8 – 34, page 9, lines 1 – 35, and page 10, lines 1 – 24, of the applicant's specification, which depict and describe a TBC system of a type known in the art). The AAPA does not explicitly teach improving the thermal fatigue life of the TBC by modifying the grain structure of the (diffusion) aluminide bond coat by (1) peening the bond coat at an intensity of at least 6A (Claim 11), specifically at an intensity of 6A to 12A (Claim 20), (2) heat treating the bond coat before depositing the TBC on the surface of the bond coat so as to recrystallize at least a surface region of the bond coat, wherein new grains form within the additive layer at the surface of the bond coat (Claim 11), specifically heat treating at a temperature and for a duration sufficient to recrystallize the entire additive layer of the bond coat, wherein equiaxial grains form within the additive layer (Claim 20), and (3) producing new, equiaxed grains that have a grain size of about 15 to 30 micrometers (Claim 20). Nakamura et al. teaches that, after depositing a diffusion coating layer of Al (i.e., a diffusion aluminide bond coat) on the surface of a gas turbine component such as a blade (i.e., a process analogous to that taught by the AAPA), the diffusion coating layer is shot-peened and then heated to a temperature at or above the recrystallization temperature of the coating layer,

thereby causing recrystallized grains (i.e., "new grains") to form on the surface of the diffusion coating layer (i.e., in the additive layer of the diffusion aluminide bond coat) (Abstract). This recrystallization process advantageously allows the component / coating (1) to have an improved thermal fatigue resistance without deteriorating the corrosion resistance, (2) to have a low crack propagation speed due to the small grain size of the recrystallized grains, and (3) to have an increased resistance to the coating layer peeling-off (Abstract). Therefore, it would have been obvious to one of ordinary skill in the art to improve the thermal fatigue life of the TBC system of the AAPA by modifying the grain structure of the aluminide bond coat by recrystallizing at least a surface region of the aluminide bond coat prior to depositing the TBC on the surface of the bond coat, wherein new grains form at the surface of the bond coat, as taught by Nakamura et al., with the reasonable expectation of successfully and advantageously providing the coated superalloy component / blade of the AAPA with the following benefits: (1) an improved thermal fatigue resistance, (2) a lower crack propagation speed, and (3) an increased resistance to the peeling-off of the coating layer (i.e., the TBC system). The combination of the AAPA and Nakamura et al. does not explicitly teach the applicant's claimed peening intensity. However, it would have been obvious to one of ordinary skill in the art to optimize the peening intensity of the combination of the AAPA and Nakamura et al. through routine experimentation in light of the teachings of Loersch et al. (see paragraph 9 above). Regarding Claim 20, the combination of the AAPA, Nakamura et al., and Loersch et al. does not explicitly teach that the entire additive layer of the bond coat is

recrystallized by the heat-treatment step. However, Nakamura et al. does teach that the outermost surface of the diffusion coating layer is recrystallized (Abstract). This "outermost surface of the diffusion coating layer" appears to correspond to the "additive layer" of the AAPA (i.e., as opposed to the diffusion zone portion of the diffusion coating, which is located within the component itself). It would have been obvious to one of ordinary skill in the art to heat-treat the diffusion bond coating of the AAPA for a temperature and time sufficient to recrystallize the entire additive layer of the bond coat with the reasonable expectation of successfully and advantageously maximizing the benefits of the recrystallization taught by Nakamura et al., such as providing the entire additive layer with a relatively small grain size, thereby most effectively retarding crack propagation. Further regarding Claim 20, the combination of the AAPA, Nakamura et al., and Loersch et al. does not explicitly teach that the new grains are equiaxial and have a grain size of from 15 to 30 micrometers. Specifically, the aforementioned combination is silent regarding the orientation and size of the recrystallized grains. However, the combination of the AAPA, Nakamura et al., and Loersch et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the grain orientation and size obtained by the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the

combination of the AAPA, Nakamura et al., and Loersch et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA, Nakamura et al., and Loersch et al. would have inherently produced equiaxial grains having a size of from 15 to 30 micrometers, unless essential process steps and/or limitations are missing from the applicant's claims. Additionally, the combination of the AAPA, Nakamura et al., and Loersch et al. teaches that the surface of the aluminide bond coat has surface irregularities as a result of grain boundary ridges defined by the grain boundaries at the surface of the aluminide bond coat (AAPA at Figure 2, page 9, lines 1 – 35, and page 10, lines 1 – 7), and following the recrystallizing step, the new, equiaxed grains cause the surface of the bond coat to be smoother and flatter as a result of eliminating at least some of the grain boundary ridges, whereby the ceramic layer is deposited on the smoother and flatter surface of the aluminide bond coat. Specifically, the combination of the AAPA Nakamura et al., and Loersch et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat deposited, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the flattened grain boundary ridges and smoother bond coat surface obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA, Nakamura et al., and Loersch et al. teaches the claimed recrystallization (i.e., peening / heating) process,

the process of the combination of the AAPA, Nakamura et al., and Loersch et al. would have inherently produced a bond coat having flattened grain boundary ridges and a smoother bond coat surface on which the ceramic layer / TBC is deposited, as required by Claims 11 and 20.

11. The combination of the AAPA, Nakamura et al., and Loersch et al. also teaches all the limitations of **Claims 13 – 18** as set forth above in paragraph 10 and below, including a method wherein / further comprising:

- Claim 13: The new grains have a grain size of not smaller than 5 micrometers after the TBC has been deposited. Specifically, although Nakamura et al. teaches that the new grains are “small” and “fine” (Abstract), Nakamura et al. is silent as to the specific size of the recrystallized grains. However, the combination of the AAPA, Nakamura et al., and Loersch et al. teaches each and every process step and limitation of the applicant’s claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the grain size obtained by the applicant’s claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the aforementioned combination of references teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination references would have inherently produced new

grains having a grain size of not smaller than 5 micrometers unless essential process steps and/or limitations are missing from the applicant's claims.

- Claim 14: The new grains are substantially equiaxed. Specifically, Nakamura et al. is silent regarding the orientation of the recrystallized grains. However, the combination of the AAPA, Nakamura et al., and Loersch et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the grain orientation obtained by the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of references teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of references would have inherently produced substantially equiaxed grains unless essential process steps and/or limitations are missing from the applicant's claims.
- Claim 15: The aluminide bond coat is a single-phase or two-phase aluminide prior to recrystallization (page 9, lines 17 – 22, of the applicant's specification).
- Claim 16: Precipitates are substantially absent from the grain boundaries of the new grains after recrystallization. Specifically, the combination of the AAPA, Nakamura et al., and Loersch et al. is silent regarding precipitates at

the grain boundaries after recrystallization. However, the aforementioned combination of references teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the lack of grain boundary precipitates obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the combination of the AAPA, Nakamura et al., and Loersch et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the aforementioned combination of references would have inherently produced a bond coat having substantially no precipitates at the grain boundaries after recrystallization unless essential process steps and/or limitations are missing from the applicant's claims.

- Claim 17: The aluminide bond coat is single-phase aluminide after recrystallization. Specifically, the AAPA teaches that the bond coat, as deposited, is a single-phase or two-phase diffusion aluminide (page 9, lines 17 – 19, of the applicant's specification). Additionally, the combination of the AAPA, Nakamura et al., and Loersch et al. teaches each and every process step and limitation of the applicant's claims, including the type of aluminide bond coat deposited, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the

bond coat at a temperature at or above the recrystallization temperature.

Since the single phase aluminide obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant (for support, see, for example, page 14, lines 18 – 20 of the applicant's specification, which indicates that a bond coat recrystallization process yields a single-phase), and the combination of the AAPA, Nakamura et al., and Loersch et al. teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA, Nakamura et al., and Loersch et al. would have inherently produced a bond coat having a single-phase aluminide structure unless essential process steps and/or limitations are missing from the applicant's claims

- Claim 18: The aluminide bond coat is a platinum aluminide bond coat (page 9, lines 11 – 19 of the applicant's specification).

12. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) in view of Nakamura et al. (JP 01-180959 A), and in further view of Duhl et al. (USPN 4,512,817).

13. The combination of the AAPA and Nakamura et al. teaches all the limitations of **Claim 3** as set forth above in paragraph 6, except for a method wherein the aluminide bond coat is heated to a temperature of about 1090° C to about 1120° C during the recrystallizing step. Specifically, Nakamura et al. teaches heating the

bond coat to a temperature at or above the recrystallization temperature of the coating (Abstract) and gives a specific example of heating to a temperature of 900° C (sections (9) and (10) of Nakamura et al., as verified by an oral translation from a USPTO translator). Duhl et al. teaches that the temperature of the post-deposition heat treatment of a bond coating is a result / effective variable that depends on various factors such as (1) the amount of coating interdiffusion desired, (2) the type of coating, (3) the substrate composition, and (4) the coating thickness (Col.3, lines 8 – 40). A high heat treatment temperature such as 2050° F (i.e., 1121° C – “about 1120° C”, as claimed by the applicant) can be utilized (Col.4, lines 7 – 16). It would have been obvious to one of ordinary skill in the art to utilize a high heat treatment temperature of, for example, about 1120° C (as taught by Duhl et al.), in the process of the combination of the AAPA and Nakamura et al. with the reasonable expectation of (1) success, as Nakamura et al. teaches heating the bond coat to a temperature at or above the recrystallization temperature of the coating (i.e., does not appear to place an upper limit on the heat treatment temperature) and (2) obtaining the benefit of using a higher heat treatment temperature than the 900° C temperature explicitly taught by Nakamura et al., such as performing the recrystallization more quickly, thereby increasing process throughput.

14. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) in view of Nakamura et al. (JP 01-180959 A), in

further view of Loersch et al. (USPN 4,514,469), and in further view of Duhl et al. (USPN 4,512,817).

15. The combination of the AAPA, Nakamura et al., and Loersch et al. teaches all the limitations of **Claim 12** as set forth above in paragraph 10, except for a method wherein the aluminide bond coat is heated to a temperature of about 1090° C to about 1120° C. However, this limitation would have been obvious to one of ordinary skill in the art in view of the teachings of Duhl et al. (see paragraph 13 above).
16. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) in view of Nakamura et al. (JP 01-180959 A), in further view of Loersch et al. (USPN 4,514,469), and in further view of Duderstadt et al. (USPN 5,238,752).
17. The combination of the AAPA, Nakamura et al., and Loersch et al. teaches all the limitations of **Claim 19** as set forth above in paragraph 10, except for a method wherein tantalum-rich precipitates are present in the grain boundaries of the grains after the depositing step and before recrystallization, and the tantalum-rich precipitates are substantially absent from the grain boundaries of the new grains after recrystallization. However, the AAPA does teach that refractory phases "46" (i.e., precipitates) are present in the grain boundaries "34" of the grains after the depositing step and before recrystallization (Figure 2 and page 9, lines 20 – 35, of the applicant's specification). The refractory phases form during the bond coat deposition as a result of diffusion of refractory elements from the superalloy

substrate (page 9, lines 32 – 35 of the applicant's specification). Additionally, the AAPA teaches that the substrate is a nickel or cobalt-based superalloy (page 8, lines 8 – 15, of the applicant's specification) but is silent regarding the specifics of the aforementioned superalloy. Duderstadt et al. teaches that typical nickel-based superalloy materials used to make turbine blades comprise tantalum (Col.4, lines 39 – 45, Col.8, lines 28 – 46, and Col.9, lines 35 – 43), and a certain amount of this tantalum diffuses into the bond coat from the substrate (Col.6, lines 14 – 22). It would have been obvious to one of ordinary skill in the art to utilize the specific, tantalum-containing nickel-based superalloy materials taught by Duderstadt et al. in making the nickel-based superalloy turbine blades of the AAPA, thereby performing a process in which tantalum-rich precipitates diffuse from the substrate and are present in the grain boundaries after depositing the bond coat (as taught by the AAPA and Duderstadt et al.), with the reasonable expectation of successfully and advantageously using a specific, well-known, nickel-based superalloy material (i.e., the material(s) taught by Duderstadt et al.) out of the broader genus of nickel-based superalloy materials generally taught by the AAPA in the turbine blade manufacturing process (i.e., using a known species out of a broader disclosed genus). Please note that the selection of a known material based on its suitability for its intended use supports a *prima facie* obviousness determination (See MPEP 2144.07). Additionally, the aforementioned combination of references is silent regarding tantalum-rich precipitates at the grain boundaries after recrystallization. However, the aforementioned combination of references teaches each and every

process step and limitation of the applicant's claims, including the type of aluminide bond coat utilized, the step of peening the bond coat prior to heat-treating the bond coat, and the step of recrystallizing the bond coat by heating the bond coat at a temperature at or above the recrystallization temperature. Since the lack of grain boundary precipitates obtained in the applicant's claimed process is simply a function of the recrystallization (i.e., peening / heating) process utilized by the applicant, and the aforementioned combination of references teaches the claimed recrystallization (i.e., peening / heating) process, the process of the combination of the AAPA, Nakamura et al., Loersch et al., and Duderstadt et al. would have inherently produced a bond coat having substantially no precipitates, including tantalum-rich precipitates, at the grain boundaries after recrystallization unless essential process steps and/or limitations are missing from the applicant's claims.

Response to Arguments

18. Applicant's arguments filed on 7/5/2004 have been fully considered but they are not persuasive.
19. A summary of the applicant's arguments follows. To begin, the applicant states that the claimed invention is directed to a process of improving the spallation resistance of a TBC coating by modifying the grain structure of a diffusion aluminide bond coat on which the TBC is deposited. The applicant states that, in this type of TBC-system, the TBC spalls as a result of cracks within an alumina scale that grows on the bond coat and/or at the interface between the bond coat and alumina scale, not as a result

of cracks propagating through the diffusion aluminide bond coat. The applicant argues that all of the benefits ascribed to Nakamura's teachings concern improving the thermal fatigue resistance, reducing crack propagation speed, and increasing the peel-off resistance of a diffusion aluminide coating, and such problems do not exist in the AAPA's TBC system (e.g., because TBC spallation on a diffusion aluminide bond coat is due to a fatigue mechanism that is not the result of crack propagation through the bond coat or its grain boundaries). Therefore, the applicant argues that there is no motivation to apply Nakamura's teachings to the AAPA's TBC system, and it would be totally unexpected that recrystallization of the bond coat could have anything to do with TBC life.

20. The examiner has carefully considered the aforementioned arguments, but they are not convincing for the following reasons. The crux of the applicant's argument is that Nakamura's teachings concern improving the properties of a diffusion aluminide coating, and the problems associated with a diffusion aluminide coating do not exist in the AAPA's TBC system because the TBC system does not fail due to a failure of the diffusion aluminide bond coat. In response, this argument (i.e., that the problems associated with a diffusion aluminide coating do not exist in the AAPA's TBC system) appears to be based on speculation on the part of the applicant and is not supported by evidence of record. The applicant's TBC system, as claimed and disclosed, comprises a diffusion aluminide bond coat. As such, one of ordinary skill in the art would have reasonably expected that problems (e.g., peeling-off, thermal fatigue, cracking and crack propagation, etc.) typically associated with diffusion

aluminide coatings would be extremely relevant to diffusion aluminide bond coat-based TBC systems, such as that of the AAPA. As admitted by the applicant, Nakamura's teachings concern improving the thermal fatigue resistance, reducing crack propagation speed, and increasing the peel-off resistance of a diffusion aluminide coating. Since the TBC system of the AAPA comprises such a diffusion aluminide coating, one of ordinary skill in the art would have been highly motivated to apply Nakamura's teachings to the AAPA's TBC system. Additionally, the examiner notes that the applicant's position and argument that, in the TBC-system of the AAPA, the TBC spalls as a result of cracks within an alumina scale that grows on the bond coat and/or at the interface between the bond coat and alumina scale, not as a result of cracks propagating through the diffusion aluminide bond coat, does not appear to be entirely accurate. In the sentence bridging pages 2 and 3 of the applicant's specification, the applicant states that, "... TBC deposited on diffusion aluminide bond coats typically spall at the alumina-to-bond coat interface or within the alumina layer itself". This statement clearly indicates that, in some cases, the TBC deposited on diffusion aluminide bond coats spalls at other locations. As such, one of ordinary skill in the art would have looked to improve the properties of each layer / coating in the TBC system of the AAPA to reduce the chances that failure would occur at any point in the system. Since Nakamura's teachings concern improving the thermal fatigue resistance, reducing crack propagation speed, and increasing the peel-off resistance of a diffusion aluminide coating, and a diffusion aluminide coating is part of the TBC system of the AAPA, one of ordinary skill in the

art would clearly have been motivated to perform the process of Nakamura in conjunction with the TBC system of the AAPA in order to improve the properties of the diffusion aluminide bond coating and the TBC system as a whole. To conclude, please note that the fact that applicant has recognized another advantage (e.g., that recrystallizing a diffusion aluminide bond coat reduces failure due to cracks within an alumina scale that grows on the bond coat and/or at the interface between the bond coat and alumina scale) which would flow naturally from following the suggestion of the prior art (i.e., recrystallizing a diffusion aluminide coating to reduce failure due to cracks within the aluminide coating itself, as taught by Nakamura) cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter., 1985).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wesley D Markham whose telephone number is (571) 272-1422. The examiner can normally be reached on Monday - Friday, 8:00 AM to 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive Beck can be reached on (571) 272-1415. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Art Unit: 1762

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

WDM

WDM

Wesley D Markham
Examiner
Art Unit 1762



SYRE P. BECK
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700